Enhancing EPHTN with NASA Earth Science Results

First Annual Report

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Overview

Early in the year, the project was named the Environmental Public Health Application Systems (ENPHASYS) in keeping with NASA's systems approach concept. The primary goal of ENPHASYS is to enhance the New Mexico Environmental Public Health Tracking System (EPHTS) and by extension, the Center for Disease Control and Prevention (CDC) Environmental Public Health Tracking Network (EPHTN) with model outputs and forecasts for atmospheric ozone, dust, and other aerosols that trigger asthmatic responses or myocardial infarction. NASA Earth observation data from MODIS and CALIPSO are being used to improve and validate forecasting capabilities of the Dust Regional Atmospheric Model (DREAM) and the Community Multi-scale Air Quality (CMAQ) model. Activities during the first project year focused on preparing the models, developing dust masks to better identify dust sources, exploring the utility of CALIOP data, and providing tabular data of dust forecasts for EPHTS. Highlights of accomplishments are described below.

The project is led by the Earth Data Analysis Center (EDAC) at the University of New Mexico, in partnership with the Atmospheric Sciences Department at the University of Arizona and the Environmental Health Epidemiology Bureau at the New Mexico Department of Health.

Significant Highlights

Modeling

NMM In an earlier project DREAM was nested within the NCEP/eta weather forecasting model. A newer model, the Non-hydrostatic Mesoscale Model (NMM), provides better resolution output than Eta and is the model into which DREAM has been nested for ENPHASYS. To expedite the run time of the model, NMM was installed on two of the University of Arizona's super computers to identify which computer configuration is more beneficial for the appropriate type of run and/or application. Test runs appear realistic, but real observations are needed to verify the results. This task is significant because it enables running the model to generate 72-hour forecasts at a 3-5 kilometer spatial resolution with 8-bin particle size capability.

CMAQ Initially, Dr. Yin was to perform the CMAQ modeling task for ENPHASYS. With his departure from the team in fall 2007, a search was initiated to locate a modeler who could execute this task. Under a subcontract from the University of Arizona, Dr. Maudood Khan at Marshall Space Flight Center was brought onboard to conduct the CMAQ modeling requirements for the project. A parallel workflow for both the DREAM/NMM and CMAQ was developed (Figure 1) and will be executed in the second project year. It consists of two parts that will ultimately be merged. Part I aims to insert monthly dust masks into

NCEP/NMM to produce hourly dust values. Part II aims to generate 4 and 12 km resolution simulations of dust and ozone using CMAQ. One uses NCEP/NMM; the other, WRF-ARW.

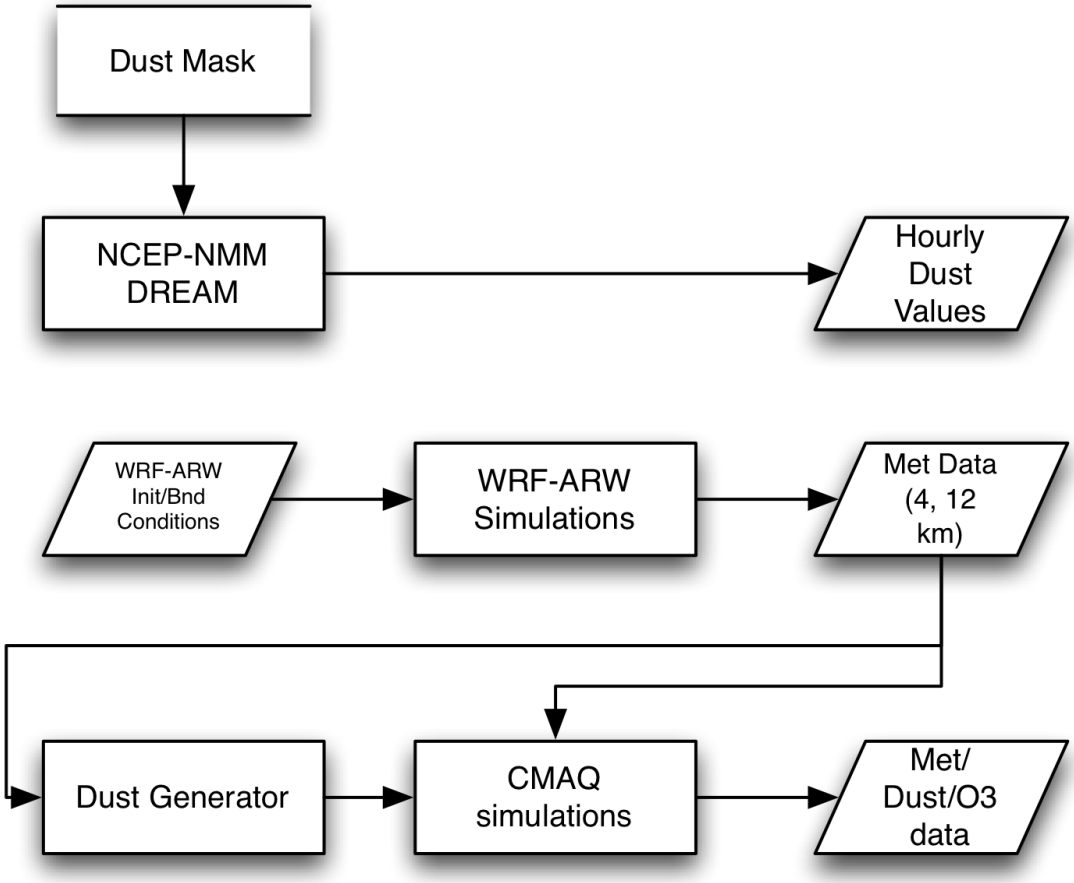

Figure 1. Parallel workflow for DREAM and CMAQ.

ESR Data

Dust Masks One of the enhancements to DREAM in an earlier project was the use of the MODIS MOD12Q1 barren land category from the land cover product as an input parameter, replacing the Oslen World Ecosystems classification. This MODIS product provided an improved spatial resolution output, but it is not refreshed on a regular basis. To produce better dust forecasts it is important to pinpoint the dust sources. These sources conceivably change due to seasonality and climate variability. Agricultural land, for example, could be a point source for dust when in non-production. Using MODIS NDVI 16-day composites, non-production agricultural land was classified through a multi-step process and added to the MOD12Q1 barren land class to create seasonal dust masks over the model's domain. Seasonal changes that are possible dust sources are illustrated in Figure 2. The barren class (shown in red) for MOD12Q1 is derived from a product developed in 2001, therefore no seasonal changes are evident. The non-cultivated lands (shown in yellow) indicate seasonal changes. Note, for example, the February 2008 image compared to the October 2008 image. While the dust masks have not been tested yet in the model, it is expected that improvements in DREAM's performance will be realized. The dust masks also will be tested in the CMAQ model. This is an important accomplishment because it provides a significant dynamic input parameter for modeling dust forecasts.

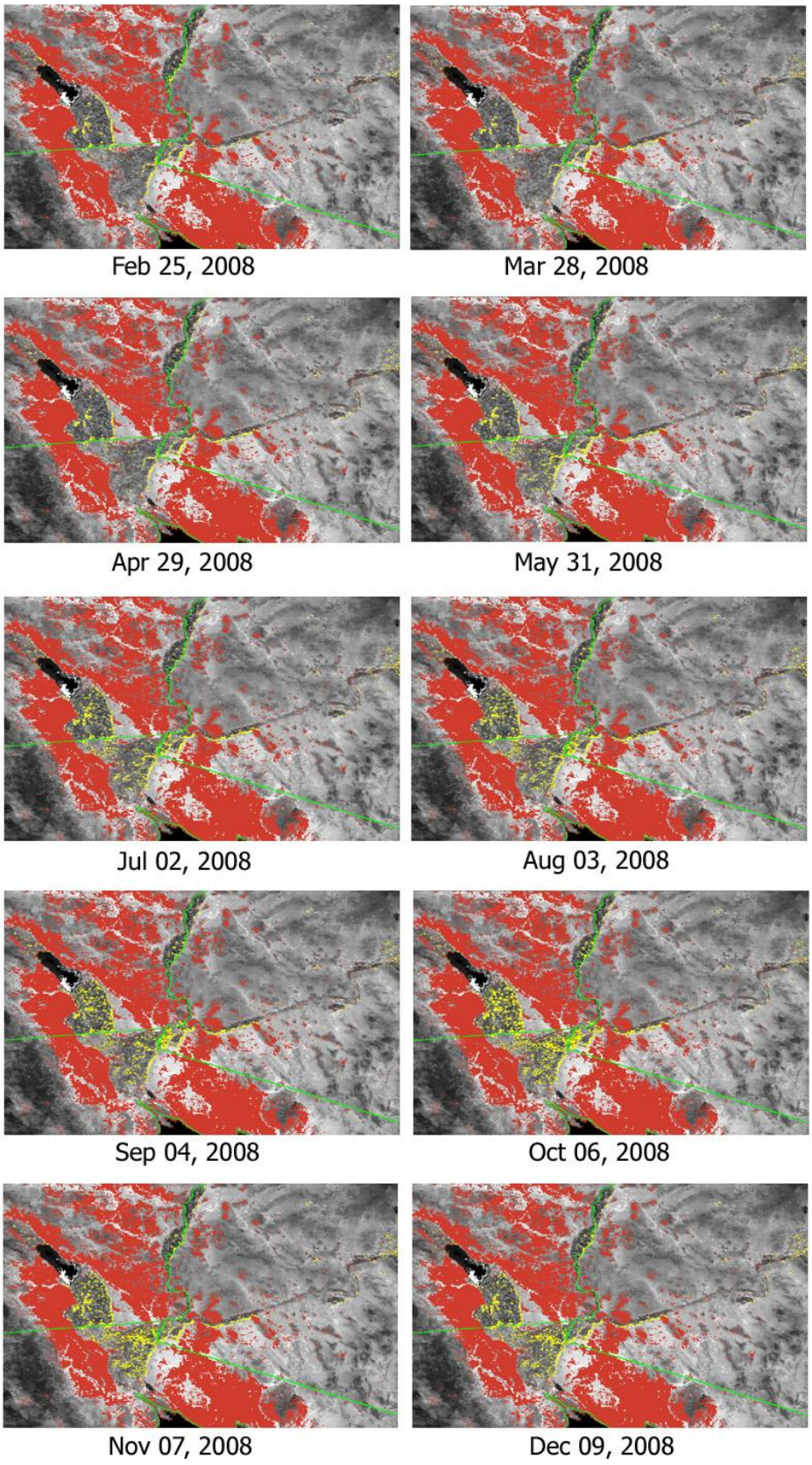

Figure 2. Monthly dust masks for the lower Colorado River Valley (southeastern California and southwestern Arizona). Red indicates barren class from MOD12Q1 and yellow represents non-cultivated land.

Enhancing NM EPHTS

The New Mexico Environmental Public Health Tracking (NM EPHT) Program deployed its Web Application Portal on September 1, 2008, which serves as the baseline for measuring enhancements to the system through ENPHASYS. The interactive, dynamic portal includes a project website that disseminates information and static graphs and maps for environmental exposures and health outcomes, as well as current air quality maps for the state. CDC requirements include capabilities for secure data requests and transmissions, secure role-based access, data discovery, and data presentation via table and mapping functions and metadata records. Data sets were based upon CDC nationally-consistent data and measures for air and drinking water quality and health effects/outcomes, such as asthma and myocardial infarction, and were provided through distributed data provider services. The n-tiered architecture of interacting services for EPHTS is illustrated in Figure 3. The ENPHASYS project will contribute new components (yellow boxes) and enhance others (red boxes) to this system. The website and portal can be accessed at http://nmtracking.unm.edu.

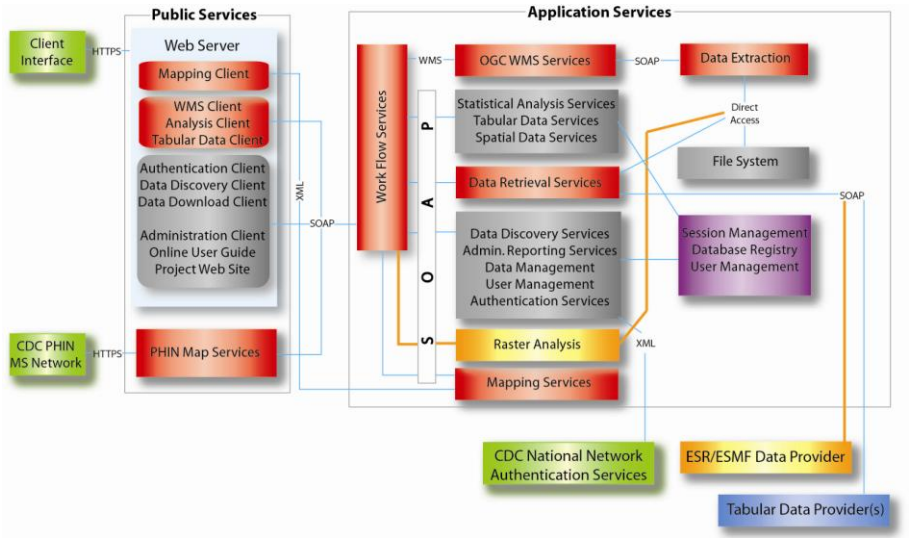

Figure 3. Architecture for NM EPHTS showing existing elements in grey, expected enhancements in red, and new components in yellow. Green boxes are CDC elements.

During the first project year a new ERS/ESMF data provider was added to the system that delivers DREAM dust forecasts in tabular formats aggregated to the county level. These are summarized air quality data for PM $_{2.5}$ and PM_{10} that are presented as a table and that can be visualized using the EPHTS mapping application tool. Users access the dust concentration data via the data discovery page in EPHTS from which they can select a specific date for viewing the tabular data or for mapping the county level summarized data (Figures 4 and 5).

Dust concentration forecast PM 10 by county

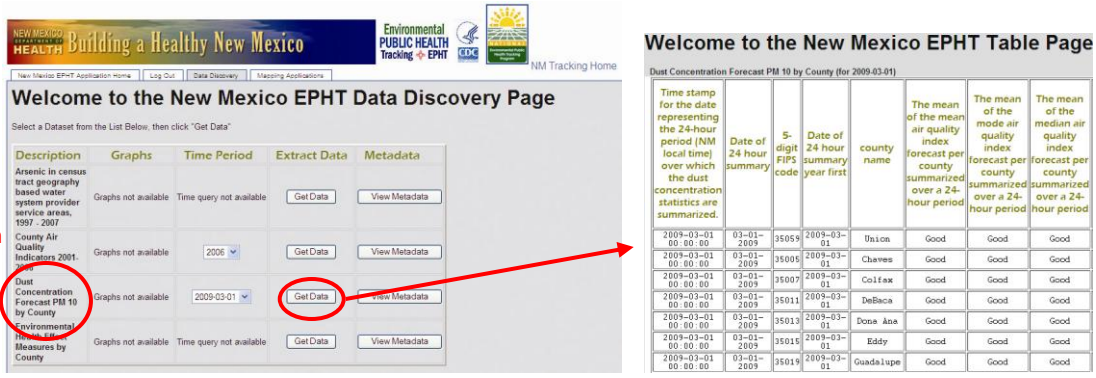

Figure 4. DREAM dust forecast data are accessible via the EPHT Data Discovery Page (left) and presented as a table (right).

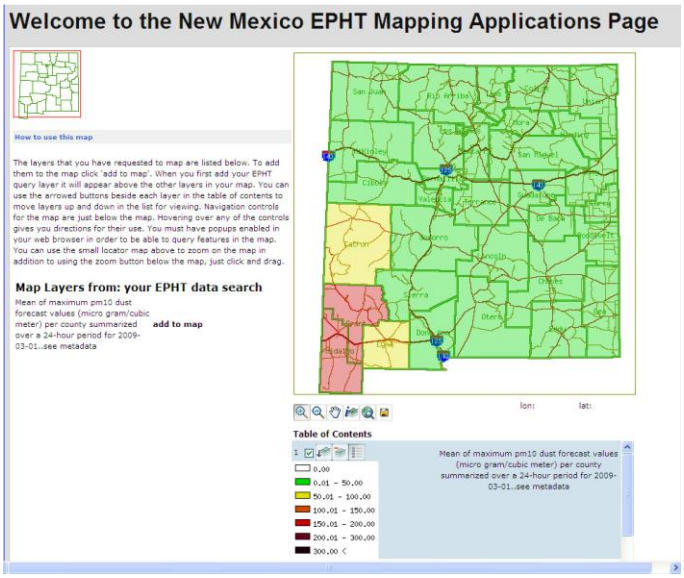

Figure 5. Dust concentrations aggregated to the county level presented as a static map.

In addition to the tabular and map products, the portal website links to animated visualizations of 48-hour dust daily forecasts (Figure 6). These forecasts are generated by the DREAM model that is run daily on a server at EDAC.

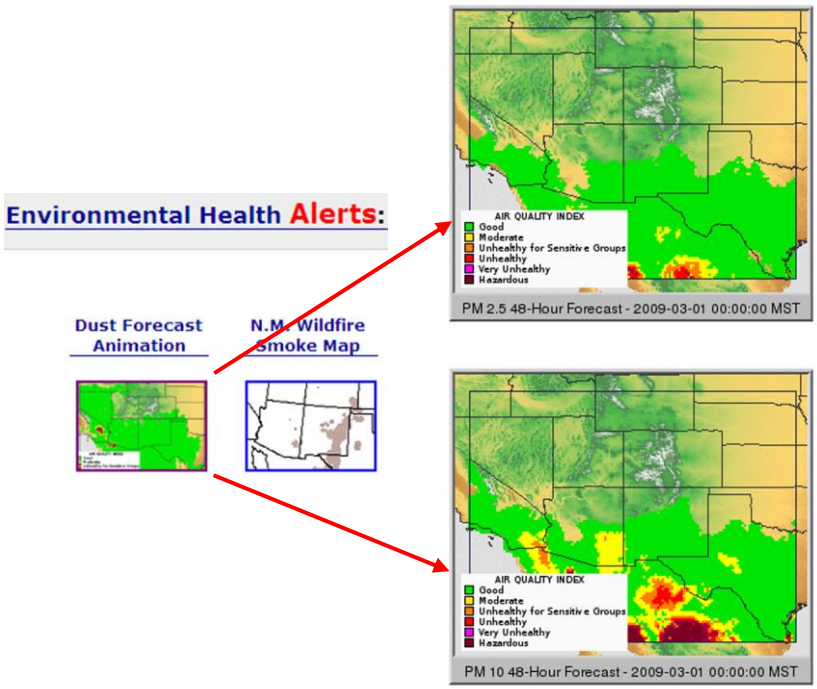

Figure 6. Animated 48-hour dust forecasts are viewable from the EPHTS home page.

These enhancements to EPHTS in the first year of the ENPHASYS project are significant because through the NM Department of Health they provide a new community of users with information on concentrations of dust that are not otherwise available. Mitigating incidences of asthma and myocardial infarction are a high priority in New Mexico and being able to monitor environmental conditions that can trigger these incidences is a step forward for the health community. Additionally, accomplishments

achieved in year one for enhancing EPHTS have laid the foundation for further enhancements to the system in the next two years of the project.

Publications & Presentations

Biloxi: NASA Public Health Applications Program, Biloxi, MS, August 17-19, 2008. Adding ESR to NM/EPHTS and EPHTN. Presented by Stan Morain PI, Earth Data Analysis Center, UNM; and, Len Flowers, New Mexico Department of Health.

CDC: Tracking Conference, Washington, D.C., February 24, 2009. Enhancing the New Mexico's Tracking Network with NASA Ozone and Dust Forecast Data. Presented by Chandra Bales, and Stan Morain, Earth Data Analysis Center, UNM.

Transition Plan

Part of the proposed transition plan includes publication of a book through Taylor and Francis' ISPRS Book Series, jointly edited by the PI and Amelia Budge, Chair of ISPRS Commission VIII, Working Group 2. This volume titled *Environmental Tracking for Public Health Surveillance* will provide a state-of-the-art overview on how environmental tracking data from satellite, airborne, and ground-based sensors are being integrated into appropriate geo-physical and spatial information system models to enhance public health surveillance and decision-making from local to global levels. Subject area experts consisting of public health and environmental sciences will be formed to address sectors of public health concern. These sectors will include airborne, waterborne, and zoonotic diseases whose transmission is promoted by fluctuating environmental parameters. The volume will also address health conditions of domesticated species in context of their potential for spreading epidemics to human populations.

During March '09 a "dear colleague" letter will be widely circulated within the U.S. and abroad to identify chapter author/editors, and contributing authors.

Year-2 Work Plan April ('09 to mar '10)

Nicko/Maudood:
- document DREAM/NMM and CMAQ systems
- create naming conventions for metadata files for each run

Maudood/Benedict:
- execute the DREAM/NMM and CMAQ workflow diagram

Maudood:
- configure and run CMAQ using data for 2006-2008dust episodes
- phase-1 for CMAQ = baseline simulations [w/o dust emissions] at 12 & 4 km resolutions
- execute CMAQ simulations with DREAM-estimated dust emissions

T. Budge:
- create retrospective MOD13A2 dust masks for duration of project
- work with CALIOP Science Team to identify and select appropriate products
- learn how to develop curtain sequences to aid year-3 V&V of model runs
- select data sets that match known events.

Nicko/Peja:
- finalize testing and evaluation of DREAM/NMM (2 versions)
- assimilate dust masks & run DREAM/NMM forecasts on UA super computer

B. Sprigg:
- coordinate Nicko/Peja & UA super computer activities
- coordinate CMAQ integration into model system

Stan/Amy:
- re-visit Performance Measures & adjust as needed
- develop & begin implementing transition plan

B. Hudspeth:
- work with Myers/Benedict to define ENPHASYS "exposure-level" products
- create a system to transfer products to NMDOH & UNMHSC

NMDOH:
- coordinate a team design for a large-scale experiment in the Farmington area